

United States Patent [19]**Okabe et al.**[11] **Patent Number:** **5,723,882**[45] **Date of Patent:** **Mar. 3, 1998**[54] **INSULATED GATE FIELD EFFECT TRANSISTOR HAVING GUARD RING REGIONS**[75] **Inventors:** Naoto Okabe, Chita-gun; Naohito Kato, Kariya, both of Japan[73] **Assignee:** Nippondenso Co., Ltd., Kariya, Japan[21] **Appl. No.:** **401,506**[22] **Filed:** **Mar. 10, 1995****Related U.S. Application Data**

[63] Continuation-in-part of Ser. No. 221,002, Apr. 1, 1994, abandoned.

[30] **Foreign Application Priority Data**

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[51] **Int. Cl.⁶** **H01L 29/74; H01L 29/76; H01L 23/58**[52] **U.S. Cl.** **257/139; 257/147; 257/170; 257/173; 257/368; 257/487; 257/488; 257/490**[58] **Field of Search** **257/139, 147, 257/153, 170, 173, 487-490, 355, 368**[56] **References Cited****U.S. PATENT DOCUMENTS**

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Primary Examiner—Tom Thomas

Assistant Examiner—Fetsum Abraham

Attorney, Agent, or Firm—Cushman, Darby & Cushman IP Group of Pillsbury, Madison & Sutro LLP

[57] **ABSTRACT**

An insulated gate field effect transistor comprising a semiconductor substrate having one side on which a cell area is composed of a plurality of first wells of a first conductivity type, each of the first wells containing a source region of a second conductivity type. A channel region is defined in the surface portion of the semiconductor substrate adjoining to the source region, and a gate electrode is formed, via a gate insulating film, at least over the channel region. A source electrode is in common contact with the respective source regions of the plurality of first wells. The semiconductor substrate has a drain electrode provided on another side. A current flows between the source electrode and the drain electrode through the channel being controlled by a voltage applied to the gate electrode. A guard ring area is disposed on the one side of the semiconductor substrate so as to surround the cell area. The source electrode has an extension connected to a second well of a second conductivity type formed in the one side between the cell area and the guard ring area to provide a by-pass such that, when a current concentration occurs within the guard ring area, the concentrated current is conducted directly to the source electrode in the cell area through the by-pass, thereby preventing the concentrated current from causing a forward biasing between the first wells and the source region.

19 Claims, 17 Drawing Sheets